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(54) A PROCESS FOR THE PREPARATION OF ACTIVE CARBON FROM SLUDGE FROM WASTE WATER TREATMENT PLANTS

(71) We, AB THULE-THERM, a joint-stock company organised under the laws of Sweden of Sveavägen 28—30, 111 34 Stockholm, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a process for the preparation of active carbon from sludge from wastewater treatment plants.

The demand for environmental management has made it desirable to find a solution of the problems arising when sludge has been concentrated in modern-type wastewater treatment plants. Irrespective of the method employed, the treatment has resulted in great amounts of sludge which in many cases is difficult to handle due to its consistency and which is moreover a nasty-smelling gruel and contains harmful substances such as pathogenic bacteria.

Many drawbacks can be avoided by means of heat drying this sludge. A granulated odourless product is obtained, and by the heat treatment the product will be pasteurized and will be suitable for use as a soil improving agent, unless the presence of toxic substances or heavy metals makes this use dangerous, at any rate in agriculture.

Sludge obtained from thickeners, i.e. settled sludge, has a dry matter content of 2—15% by weight, according to the sludge type. Drying this sludge to a dry matter content such as is suitable or optimum for fertilizer purposes, i.e. to a dry matter content above 50% by weight, means that considerable amounts of water must be evaporated. This is possible only if inexpensive heat is available, for example surplus heat in the form of flue gases from trash

burning furnaces. Such plants have been in operation for several years.

If no such surplus heat is available the sludge is normally dewatered by mechanical means, e.g. centrifuges, filter presses, vacuum filters etc. In this way the dry matter content is increased from 2—15% by weight to 15—35% by weight, according to the sludge type. By this dewatering a thicker, drier sludge is obtained but the product is still difficult to handle and like the starting material it contains pathogenic bacteria and in certain cases hydatids. Spreading such a product onto arable land can be inappropriate. As stated above, a more suitable product, pelletized and pasteurized, is obtained by heat drying.

Since the possibilities are small in certain areas to deposit such a dried sludge or to spread it as a soil improving agent, an alternative way of sludge disposal in such areas has been to burn the sludge in order to decrease its volume. However, burning the sludge gives rise to other disadvantages:

(i) During the burning, gases containing e.g. hydrocarbons, hydrogen chloride, sulphur oxides, nitrogen oxides and mercaptans are formed. Said gases cannot be removed and absorbed without great expenditures; most often scrubber devices are used.

(ii) The ashes constitute a concentrated form of non-combustible impurities, e.g. oxides of heavy metals. Deposition of said ashes, locally concentrated, involves a great risk of leaching due to the action of rain-water which may have a pH value varying within a range of between 3 and 7, this pH value tending to go more and more toward the lower end of said range the more industrialized the area is, and the denser its population. This can give rise to an insanitary infiltration of the ground water.

[Price 33p]

Thus, since neither heat drying nor burning of the sludge gives a completely acceptable solution a development has been started to carbonize the sludge, i.e. to prepare a product by pyrolysis which due to its carbon content cannot be leached. The active carbon in the product will thus adsorb the harmful substances, and the product itself is of substantial value as an absorbing and adsorbing material for a great number of solid or gaseous substances which at present cannot be separated and bonded except by means of active carbon.

When preparing active carbon it is a great advantage if the carbon can be obtained in the form of a granular porous product, thus avoiding dust formation. Furthermore, such a product is easy to handle and is very permeable, i.e. it presents only little resistance to the liquids and gases to be filtered. It is desirable that the surface area of the carbon should be as great as possible.

It is further of substantial importance that the combustible and nasty-smelling gases formed during the carbonization or pyrolysis can be collected and destroyed without the use of expensive and complicated destruction methods.

If the whole process is carried out in a single thermal step this will involve considerable difficulties. A single step process may comprise continuous indirect heating, drying and carbonization in one step. Alternatively the sludge may be heated, dried and carbonized in a single thermal step by direct counter-current heat transfer. Both of these methods have substantial drawbacks. The indirect method gives rise to corrosion problems and this method is very expensive, especially when the carbonization has to take place at temperatures above 800°C. The direct single step method gives rise to control problems since the moisture content of the initial sludge is high and subject to variation. It may thus happen that an uncarbonized product is obtained or that the product catches fire and is burnt to ashes. Moreover, the carbonization as well as the burning will often give rise to smoke formation and to an unpleasant smell of the effluent gases.

The present invention overcomes the above mentioned drawbacks and provides a simple method of converting an unpleasant and cumbersome waste product into a product which is useful for many purposes, especially in connection with environmental management.

As mentioned above, the present invention relates to a process for the preparation of active carbon from sludge from waste water treatment plants, wherein the sludge is dried in a first thermal step to a dry matter content of at least 50% by weight, whereupon the dried product is pyrolyzed

in a second thermal step by contacting it with hot combustion gases under non-oxidising conditions. Preferably, the gases formed during pyrolysis are recycled to the drying step for combustion.

Between the first and the second step the dried product may, if desired, be sprayed with a liquid which may contain organic material. Said liquid may be e.g. pure water, oil sludge, tall oil or sulphite waste liquor. By such a spraying several advantages are attained: The granules obtained in the drying step are stabilized so that they will not disintegrate in the pyrolysis step; if the spray liquid contains organic material it will increase the carbon content of the final product; if the spray liquid is oil sludge this spraying is a good way of utilizing and simultaneously destroying a material which is normally difficult to destroy. It is also possible to either add surfactants in order to prevent the formation of too large balls or add certain materials in order to increase the sorption capacity of the final product, for example dehydrating agents such as phosphoric acid or zinc chloride solutions. Further, a suspension of micro particles of certain clays can be added to increase the surface area of the final product. Chemical compounds having a deodorizing activity can also be added.

The first thermal step, i.e. the drying step, is carried out by means of either direct or indirect heating and either counter-currently or cocurrently. The drying may be carried out e.g. in a rotary drier. In this step the mechanically dewatered or the thickened sludge is dried from a dry matter content of 15—35% by weight or 2—15% by weight respectively to a dry matter content of at least 50% by weight, preferably 60—80% by weight. When thickened sludge is used as the starting material the use of cheap heat, e.g. waste gases, is desirable for economical reasons.

The product from the first step is then passed on to the second step which is carried out under pyrolysis conditions, e.g. in a rotary furnace, where the residual moisture is evaporated and the carbonization takes place counter-currently or cocurrently to the heating gases. The waste gases from the second step may be fed to the burner(s) employed in the drier of the first step where such waste gases are burnt and destroyed.

Also other devices can of course be used for carrying out the drying step as well as the pyrolysis step, e.g. belt driers, fluidized bed devices, fluid bed driers, multi-stage ovens.

The properties of the final product depend on the type of sludge employed as the starting material, that is, as the "feed". The smaller the content of organic material in

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the feed, the smaller will be the active carbon content in the final product. It is generally true that a digested sludge has a smaller content of organic material than a non-digested sludge; but even though the digested sludge will thus tend to contain somewhat less oxygen-consuming, biologically decomposable organic material such sludge may still contain appreciable amounts of carbonizable organic matter.

The present invention is thus of great importance both if the starting material is digested sludge and if the starting material is non-digested sludge. A general tendency in modern sludge treatment industry appears to be that the expensive and space requiring digestion tanks are to be avoided. It is therefore a particular advantage that the novel process of this invention is highly satisfactory also for handling raw or non-digested sludge. Since the active carbon can be used as filter material, the process avoids many of the sanitary inconveniences that would arise if raw sludge or non-digested sludge were treated in accordance with conventional methods, and at the same time this raw or non-digested sludge when treated according to the present invention will give a still better final product than the digested sludge.

The invention will be illustrated by the following example.

Example

A non-digested, mechanically dewatered sludge from a waste water treatment plant was dried in a rotary drier while in direct contact with the combustion gases from an oil burner disposed in a combustion chamber connected to the rotary drier. The sludge, which was fed at a rate of 200 kg/h, had a dry matter content of 24% by weight, the dry matter containing about 50% of carbonizable material. A dried product having a dry matter content of 75% by weight was discharged from the rotary drier at a rate of 64 kg/h. The volume of the sludge decreased by about 50% during the drying and the sludge was transformed into granules having a diameter of 6—10 mm.

The dried product was fed, while it was still warm, at a rate of 64 kg-h into a brick-lined rotary furnace provided with an oil burner and with sealings in each end of the furnace to prevent leakage of gases to the atmosphere. The exhaust gas chamber of the furnace was connected through a gas conduit to the combustion chamber of the rotary drier. A reduced pressure was created in the drier and its combustion chamber by means of an exhaust gas fan arranged after the drier, and by means of this reduction in pressure the hot gases from the pyrolysis furnace were sucked into the combustion chamber of the drier where they were completely burnt. Feeding of secondary air to the burner of the pyrolysis furnace was slowly decreased so as to establish a condition or state where carbonization of the dried product took place. The heat transfer to the granules occurred (1) by radiation and (2) by regenerative heat transfer from the hot brickwork.

The final product was obtained at a rate of 25 kg/h. The product consisted of particles of irregular shapes (particle size 2—10 mm). A certain weight reduction due to loss of dust occurred during the pyrolysis.

The final product had a carbon content of 28—30% by weight, the remainder of the product comprising silicates, metal oxides and other substances. The surface area of the product was 32 m²/g, and the zinc adsorption of the product from a zinc chloride solution was 2 mg per g of the product. The product had an iodine number of about 100, and its adsorption of surfactants was about 20 mg per g of the product.

The economical value of the active carbon prepared will be evident from the following. The COD (chemical oxygen demand) reduction in four different industrial waste waters was measured after said waters were treated with (1) the above prepared carbonized product and (2) a commercial active carbon, the price of which is 30—70 times higher than the price of the product prepared according to the invention. The following results were obtained:

	COD reduction, %	
	Commercial active carbon	Active carbon accord. to the invention
Waste water No. 1	73	42
„ No. 2	66	21
„ No. 3	36	32
„ No. 4	44	12

It should be observed that the product according to the invention has not been activated by any addition of activating agents.

5 In another test tall oil was added to the dried product between the drying step and the pyrolysis step. Owing to the binding effect of the tall oil the loss of dust in the pyrolysis step was decreased and at the same time the particle size of the final product was increased.

10 WHAT WE CLAIM IS:—

15 1. A process for the preparation of active carbon from sludge from waste water treatment plants, wherein sludge is dried in a first thermal step to a dry matter content of at least 50% by weight, and the dried product is then pyrolyzed in a second thermal step by contacting it with hot combustion gases under non-oxidising conditions.

20 2. A process according to claim 1, wherein the gases formed during pyrolysis are recycled to the drying step for combustion.

3. A process according to claim 1 or 2, wherein the initial sludge has a dry matter content of 2—35% by weight.

4. A process according to any of claims 1 to 3, wherein the sludge is dried in the first thermal step to a dry matter content of 60—80% by weight.

5. A process according to any of claims 1 to 4, wherein between the two thermal steps, the dried product is sprayed with water, oil sludge, tall oil or sulphite waste liquor.

6. A process according to any of claims 1 to 5, wherein both the drying and the pyrolysis are carried out in rotary furnaces.

7. Active carbon when prepared by the process according to any of claims 1 to 6.

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